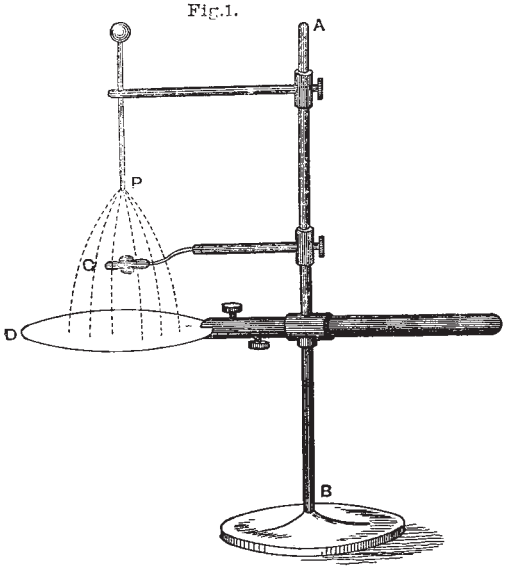
tions strongly confirm. Hence relatively warmer and moister upper currents will flow backward over the colder and drier air immediately in the rear of the centres of cyclones; and upper currents also presenting contrasts of temperature and vapour will overlap the outskirts of anticyclones. These considerations suggest how very diverse interpretations of the movements of the cirrus cloud in their relation to cyclones and anticylones have originated, and may also indicate lines of research into some of the more striking optical scenic displays of the atmosphere.

ELECTRIC SHADOWS

THE brilliant researches of Crookes upon the electric discharges in highly attenuated vacua, which some four years ago culminated in the discovery of the phenomena of "radiant matter," revealed, amongst other singular and curious effects, the existence of electric shadows. In the tubes employed by Crookes, wherein the rarefaction had been carried to millionths of the normal air pressure, objects cut out in sheets of metal or other good conductors of electricity were found to cast shadows against the glimmering surfaces of the glass

Fig. 1.



when interposed in the path of the discharge. The deflection of these shadows by the magnet was also observed by Crookes. About eighteen months afterwards some analogous phenomena were observed and described by Prof. W. Holtz of Berlin; the main difference between the phenomena observed by Crookes and by Holtz being that in the experiments of the latter the shadows were obtained at the ordinary pressure of the air by means of the discharge from a Holtz's influence machine. Of these researches some account was given at the time in NATURE (vol. xxiv. p. 130) by the writer of this article. It will be sufficient here to recall the more salient points. In the place of the usual discharging knobs of the Holtz machine were fixed a wooden disk covered with silk on the one side, and a metallic point on the other. The discharge from the latter causes the surface of the former to assume a faint, phosphorescent glow, visible only in complete darkness; and on this faintly illuminated surface shadows were cast when conducting bodies—such, for example, as crosses or rings cut from thin brass or foil, strips of damp cardboard, wires, and other similar objects. It was also noticed by Holtz that these shadow-figures could be temporarily fixed by dusting upon them some fine powder, such as lycopodium. In preparing the notice of these researches for NATURE in 1881, I made the following remark:—"These dust-figures have an obvious relation with those obtained by Wiedemann from the discharge of Leyden jars through a pointed conductor against the surfaces of various bodies. It would be interesting to ascertain whether by this process also shadow-figures can be produced." The suggestion then thrown out has not been lost, for during the current year a memoir has appeared on the subject of electric shadows from the pen of Prof. Augusto Righi, of Padua, giving

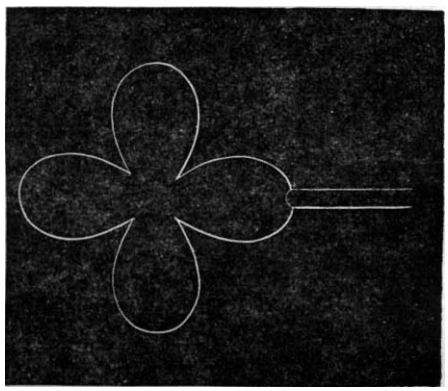


FIG. 2.

the results of an investigation of shadows produced by this very method. I propose to give here a *résumé* of the phenomena observed by Righi.

Righi discusses in an introductory way the suggestion of Crookes as to the relation between the length of the mean free path of the molecules and the distance to which the "radiant" discharge can be traced from the electrode. He observes that even in cases where the mean free path (as determined by the temperature of the

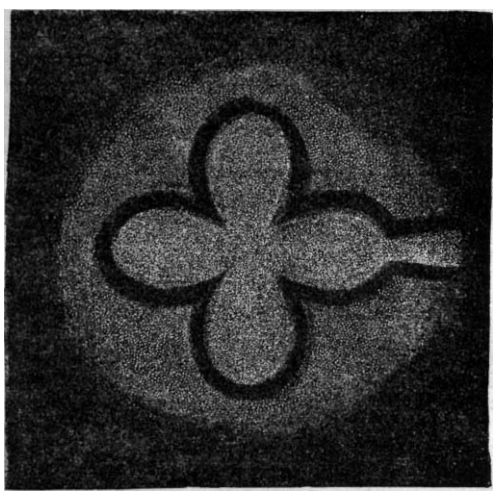


FIG. 3.

gas) be very short, as in air at ordinary pressure, the motion of the gaseous molecules as a whole may yet be in nearly straight lines of considerable length, owing to the fact that the electric force in the space where discharge is taking place will necessarily tend to urge an electrified molecule along the lines of electric force, and will act in the same direction whether the charge on any single molecule remain upon it or whether it be shared with other molecules against which it may impinge in its

flight. The only question was whether the velocity impressed by the electric action could be made relatively sufficiently great. This depended upon the magnitude of the electric density at the surface of the electrified body, and for this reason Righi used a very sharp point for the discharge. Fig. 1 shows the arrangements for obtaining the electric shadows by Righi's process. AB is an ordinary retort-stand of iron, and upon it are clamped three adjustable arms of ebonite. The uppermost of these carries a short metal rod, pointed below and terminated above in a metal ball. The intermediate support carries the object, C, which is to cast the shadow. The lowermost arm is fashioned as a clip in which can be held a disk, D, to receive the shadows. This disk is preferably of ebonite backed on its under side with brass or tinfoil. In certain cases a metal disk varnished on the upper surface is used. Fig. 2 shows a favourite form of object for casting a shadow—a floral or cruciform design cut from thin metal and mounted on a stem of ebonite or glass. To produce the shadow-figures a Leyden jar is charged to such a potential as to be able to yield a spark of 1 to 2 centimetres' length. The outer coating is put in communication with the lower surface of the disk D, and the knob of the jar communicating with its inner coating is then brought into contact with the top of the pointed rod. The jar discharges itself rapidly and almost noiselessly. Then there is immediately sifted over the disk, from a box covered with muslin, some mixed powders of minium and flowers of sulphur, in the usual manner of

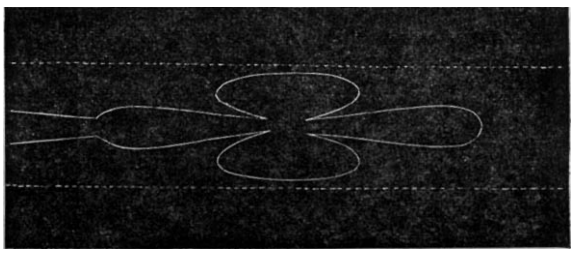


FIG. 4

procuring Lichtenberg's figures. A shadow of the interposed object is at once revealed by the powders. If the discharge has been a positive one, the shadow of the cross will appear in red surrounded by a neutral region, outside which there will be a region tinted yellow with sulphur. The colours will be reversed with a negative discharge. The shadow is depicted in Fig. 3. The size of the shadow varies with the distance of the object. Righi recommends that the object should be three centimetres above the disk, and the point twelve centimetres, or less, above the object. The lines of discharge appear to be hyperbolic in form. If a disk of ebonite only be placed at D, and the brass disk below it be lowered down, the effects are less distinct. If a narrow strip of foil or thin brass be placed below the ebonite disk, the shadow becomes compressed laterally and shows itself only on the region over the strip, and takes the form shown in Fig. 4. Similar shadows can be obtained according to Righi, on metallic disks covered with non-conducting varnish, but in this case by the use, not of the Leyden jar, but of an influence machine. This method is identical with one of Holtz's suggestion. Righi also finds that if the metal disk be previously coated with a conducting powder, such as finest zinc filings, minium, or even powdered glass, a shadow can be obtained. This method affords indeed very sharp shadows, so that thin wires and even wire gauze can be projected in shadow on the disk. Righi has gone still further, and by substituting a sensitive gelatino-bromide plate, has photographed the shadows produced during a five or ten minutes' discharge. In this experiment two figures showed themselves: one, the genuine electric shadow; the other, the genuine photographic shadow cast by the opaque object under the faint star of light emanating from the electrified point above.

If the object whose shadow is to be thus obtained is itself electrified, a curious effect is observed. If it be electrified with a charge of the same sign as that of the point above it, the shadow swells out. If electrified with a charge of opposite sign, the shadow becomes attenuated. Connecting the object to earth has the same effect as in the latter case. The presence of an electrified body on the right or left of the region in which the discharge is taking place has the effect of causing the shadow to be displaced. In fact the presence of such a body alters the equipotential surfaces, and therefore alters the lines of electric force in the field. If the discharge takes place through two points placed side by side at a short distance apart over two objects respectively beneath them, the two electric shadows are mutually repelled from the positions where their geometrical shadows lie. Similar observations of electrostatic influence were made two years ago by Messrs. Fine and Magie of Princetown, New Jersey.

Much as has been done of late years, especially by the late Mr. Spottiswoode in conjunction with Mr. J. F. Moulton, by Drs. De La Rue and Hugo Müller, by Crookes, by Goldstein, and others, to elucidate the phenomena of electric discharges, there probably still remains much to be discovered, and to be explained. The phenomena of electric shadows are amongst the matters best worthy of study in this rapidly progressing department of science. SILVANUS P. THOMPSON

NOTES

WE give this week a further instalment of notices of the strange coloured effects recently observed in the skies, and our readers in all parts of the world will render a service if they will communicate any similar facts they may have observed, giving, as far as possible, accurate dates. In an article in Saturday's *Times*, Mr. Norman Lockyer shows that the body of evidence already to hand connects them with the eruption of Krakatoa but, to place the matter beyond doubt, further information is required. The study of direction and of dates, and the facts touching the variation in the phenomena from August to December, all point in the same direction.

NO one will be surprised, though all must regret, that his state of health and advanced years have compelled Prof. Owen to resign his appointment as Superintendent of the Natural History Department of the British Museum. Prof. Owen's pre-eminent services to science, pure and applied, are too well known to require recapitulation in these columns, especially as very recently we referred to them in detail in connection with his portrait as one of our "Scientific Worthies." Advanced in years as he is, the venerable naturalist's interest in science seems as strong as ever; to each of the last two meetings of the Royal Society he contributed an important paper: we hope they will be by no means the last of such contributions.

WE learn with the greatest pleasure that Prof. Sylvester has been appointed to succeed the late Prof. Henry Smith in the Savilian Chair of Geometry at Oxford. No more worthy successor to the late Savilian Professor could have been found, and it is satisfactory to know that at last the services of one of our greatest living mathematicians have been permanently secured for his native country.

THE ceremony of distributing the prizes to the successful students of the Finsbury Technical College and the South London Technical Art School took place on Monday evening in the Hall of the Clothworkers' Company, Mincing Lane. The Lord Mayor presided, supported by the President of the Royal Society, the Sheriffs, Sir